STEAM-BOILER EXPLOSIONS

An illustrated lecture delivered at Cornell University before the student branch of the American Society of Mechanical Engineers

By WM. H. BOEHM, M. M. E.

Compliments of

The Fidelity and Casualty Company of New York

S. B. F. W. D. 133a, 15M., 2-15 (9418)

The Multiple-Indemnity Boiler Policy of The Fidelity and Casualty Company of New York

Some Prominent Features

The Multiple-Indemnity Boiler Policy of The Fidelity and Casualty Company reimburses the assured for loss caused by boiler explosions, including loss on the assured's boilers and other machinery, loss on his buildings and other property, loss on the property of others for which he is liable, and his liability for damages on account of personal injuries or death sustained by employees or by others not employees. The policy pays up to its full limit for each boiler accident that occurs at each plant during the policy term. Thus a boiler owner who has a $50,000 policy may, without the payment of any additional premium, collect as many times $50,000 as the number of times that $50,000 losses occur.

The Multiple-Indemnity Boiler Policy gives the assured the right to elect after an explosion whether settlement shall first be made for property loss or for personal injuries. Under the terms of the policy The Fidelity and Casualty Company agrees to defend at its own cost all personal injury suits brought against the assured, and to pay the costs of the defense including all court costs taxed against the assured irrespective of, that is, additional to, the limit expressed in the policy.

The Multiple-Indemnity Boiler Policy makes the personal injury indemnity excess insurance over, instead of contributing insurance with, the personal injury indemnity under the assured's liability policy, if one is carried; thus giving the assured a greater available amount of insurance to apply in the settlement of his property damage, than under any other form of policy.

The Multiple-Indemnity Boiler Policy gives the assured the right to elect, after an explosion, whether any dispute as to the amount of his property loss shall be settled by arbitration, or by other means. Thus the assured is not compelled to determine the amount by arbitration if he has reason to believe that more can be collected by other means.

The Multiple-Indemnity Boiler Policy has no general or sweeping stipulation that "any change material to the risk voids the policy". Other forms of policies usually have such a stipulation, and moreover do not define just what is a change material to the risk.

Inspection Service

The Inspection Service rendered by The Fidelity and Casualty Company under its boiler policies is recognized by eminent engineers everywhere to be the best in the land. The very considerable volume of its steam-boiler and fly-wheel business, the premium income from which amounts to nearly **half a million dollars annually,** warrants it in maintaining an engineering and inspection department of the highest possible standard, and it numbers among its clients representative concerns everywhere.

The Inspectors of the Company are **experts.** Their work is directed by Mechanical Engineers, who are devoting their best energies to this service, and who are recognized authorities on the proper construction and safe operation of steam boilers. The Company's advice is much sought and it is freely given, even to the extent of furnishing, without cost to its policyholders, complete drawings and specifications for the construction and installation of boilers and their appurtenances.

BOILER EXPLOSION, GROVER SHOE CO., BROCKTON, MASS. 58 KILLED; 117 INJURED; PROPERTY LOSS, $250,000; DEATH AND INJURY SUITS, $280,000.

Introduction by Professor R. C. Carpenter

The occasion of this lecture brings to mind another lecture delivered in this hall just twenty years ago. The subject of the lecture was "The Amoskeag Fly-Wheel Explosion," and the lecturer was Mr. Charles E. Emory.

In the audience then assembled there was a member of our post graduate class who hailed from Memphis, Tenn. His seat was just about the centre of the auditorium, and he was intensely interested in the lecture. For before entering upon his course at college he had been a draftsman in a shop that built engines and boilers; he had given fly-wheel explosions some study and he had contributed an article on the subject to one of the technical journals. After receiving our degree of Master of Mechanical Engineering he returned to practical engineering work, and for a short time was an inspector for a well-known Casualty Insurance Company. He gave up that work to become Instructor in Mechanical Engineering at Washington University and afterward became Professor of Mechanical Engineering in the State College of South Carolina.

While he was engaged in this latter work the Casualty Insurance Company with which he formerly had been connected decided to organize a Department of Fly-Wheel Insurance, and upon being invited to become its manager he accepted. This was just ten years ago, and it was ten years after Mr. Emory's lecture before referred to. Subsequently he was given the management also of its Department of Steam Boiler Insurance and I am told that the premium income to his Company from these two Departments alone now amounts to nearly half a million dollars annually.

His identification with this interesting work very naturally has made him active in matters pertaining to the construction and safe operation of steam-boilers and fly-wheels. He has contributed freely on these subjects to technical journals; he has published a pamphlet on Fly-Wheel Explosions; he is associated with me and others on a commission appointed by the American Society of Mechanical Engineers to formulate a Standard Code of Boiler Rules; and he is the Secretary of the Steam Boiler and Fly-Wheel Service and Information Bureau, an association of Casualty Companies writing boiler and fly-wheel insurance formed for the purpose of improving underwriting practices, and of lessening by means of improved inspection methods the frequency of boiler and fly-wheel explosions.

This student of twenty years ago is our lecturer to-day. His subject is "Steam Boiler Explosions", on which he is a recognized authority. Gentlemen, I take great pleasure in introducing to you Mr. William H. Boehm.

Steam-Boiler Explosions

By WM. H. BOEHM

*Member, American Society Mechanical Engineers**

FREQUENCY OF BOILER EXPLOSIONS—STRESS IN GIRTH AND SIDE SEAMS—BURSTING PRESSURE—FACTORS OF SAFETY—SAFE PRESSURE—CAUSES OF BOILER EXPLOSIONS—EXPLOSIVE ENERGY—INSPECTION AND INSURANCE—BOILER INSURANCE POLICIES.

Frequency of Boiler Explosions

Every year there occur in the United States between 1300 and 1400 serious boiler accidents, of which 300 to 400 are violent explosions. These accidents kill between 400 and 500 persons, injure 700 to 800 more, and destroy more than a half million dollars worth of property. In a single explosion, that of the R. B. Grover Shoe Company at Brockton, Mass., 58 persons were killed, 117 more were injured, $250,000 worth of property was destroyed, and an aggregate of $280,000 was claimed in the personal injury and death suits that were brought.

The photographs here reproduced give rather a grim idea of the awful havoc wrought by steam-boiler explosions. They show that these disasters have but scant respect for types—that they occur with water-tube boilers although with them violent explosions occur less frequently than with fire-tube boilers, that they occur with low-pressure boilers as well as with high-pressure boilers; with fired boilers as well as with unfired steam tanks; with small kitchen boilers as well

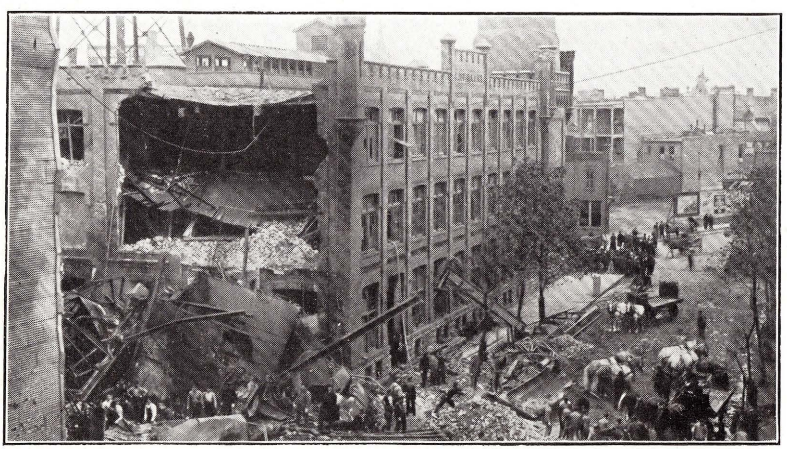
*Superintendent, Department of Steam-Boiler and Fly-Wheel Insurance, The Fidelity and Casualty Company of New York.

as with hot-water heaters, and I may add that they also occur even with the ordinary peanut roasters so familiar on crowded street corners.

These facts emphasize: the necessity of constructing and installing steam vessels and their appurtenances in as nearly perfect a manner as possible; the importance of preventing carelessness in their operation; the wisdom of having them inspected at regular intervals by disinterested experts; and the forethought of securing an adequate amount of insurance to pay the loss in case explosion occurs.

Design and Construction

It is of the utmost importance that boilers be carefully designed, that the stresses to which they are subjected be accurately computed, that suitable material be specified, that the material be critically examined for flaws or defects, that specimens of the material be tested to determine its strength, that no abuse of the material be allowed in the process of constructing the boiler, and that the completed boiler be subjected to a thorough inspection and a hydrostatic test before being put into service.



WATER TUBE BOILER EXPLOSION, PABST'S BREWERY, MILWAUKEE, WIS. 1 KILLED; 1 INJURED; PROPERTY LOSS, $114,000.

Stress in Girth and Side Seams

The stress in the girth seams of a boiler may be obtained by the formula

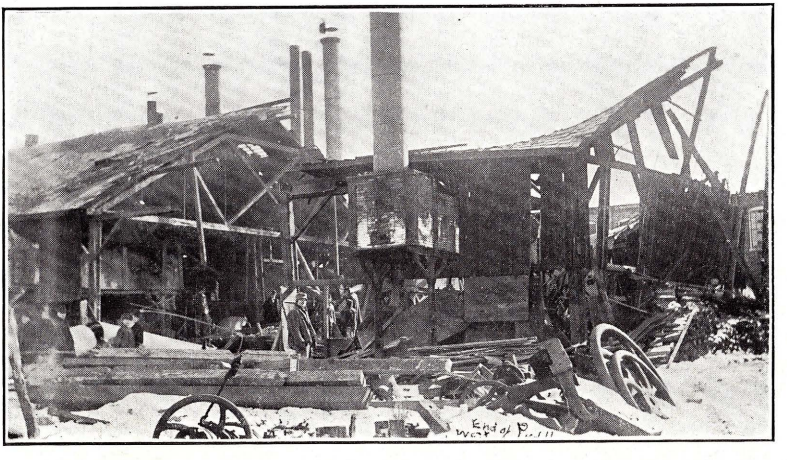
$$S = \frac{r\,p}{2\,t}$$

in which S is the stress per square inch to which the material is subjected, r the radius of the boiler, p the steam pressure carried, and t the thickness of the shell. Stated in words the formula means that if we multiply the shell radius by the steam pressure, and divide the product by twice the shell thickness, the result will be the stress in pounds per square inch to which the material in the girth seams is subjected.

The stress in a side seam of a boiler may be obtained by the formula

$$S = \frac{r\,p}{t}$$

which stated in words means that if we multiply the shell radius by the steam pressure and then divide the product by the shell thickness, the result will be the stress in pounds per square inch to which the material in a side seam is subjected.



BOILER EXPLOSION, VAN ALLEN ROLLING MILL, NORTHUMBERLAND, PA. 9 KILLED; 6 INJURED; PROPERTY LOSS, $50,000.

An inspection of these formulae shows that the stress in a side seam is just twice as great as the stress in a girth seam. It is for this reason that the side seams are usually double riveted when the girth seams are only single riveted.

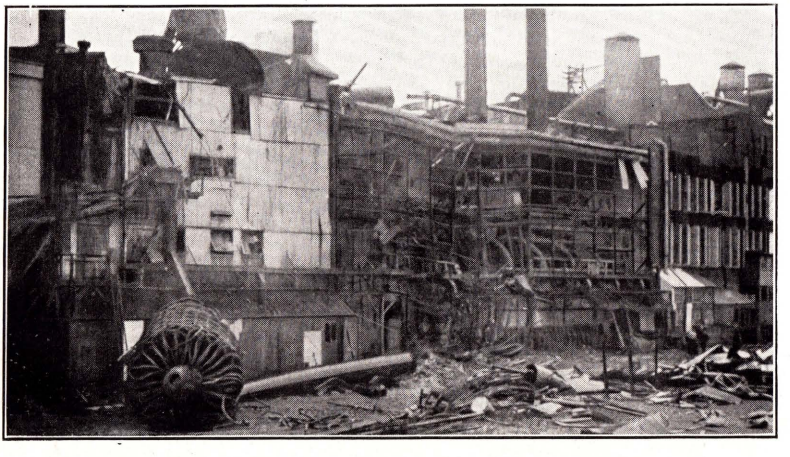
Bursting Pressure

The pressure required to rupture the shell of a cylindrical boiler is given by the formula

$$P = \frac{s\ t}{r}\ e$$

in which P is the bursting pressure in pounds per square inch, s the tensile strength of the material in the boiler, r the radius of the shell, and e the efficiency of the riveted side seam. Stated in words the formula means that if we multiply together the tensile strength of the material, the thickness of the shell, and the efficiency of the riveted side seams, and then divide the product so obtained by the radius of the shell the result will be the steam pressure at which explosion will occur.

If it so happens that the efficiency of the girth seam is too low by reason of improper design, then the girth seam may



BOILER EXPLOSION, AMERICAN MFG. CO., BROOKLYN, N. Y. 8 KILLED; SEVERAL INJURED; PROPERTY LOSS, $150,000.

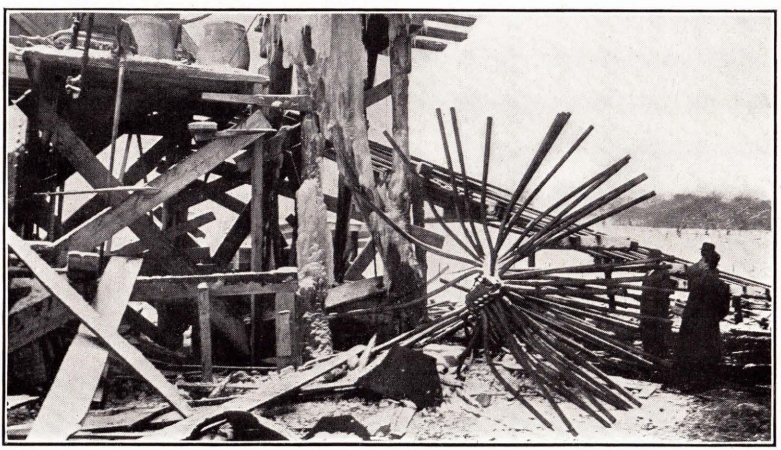
fail instead of the side seam as assumed above, in which case the bursting pressure is given by the formula

$$P = \frac{2\,t\,s}{r}\,e'$$

which stated in words means if we multiply together twice the thickness of the shell, the tensile strength of the material, and the efficiency (e′) of the girth seam, the result will be the steam pressure at which explosion will occur. It is to be observed, however, that the girth seam is not likely to fail before the side seam, because to do so the efficiency of the girth seam would have to be less than half that of the side seam—a weakness that should not exist in a boiler of proper design and construction.

Factors of Safety

It is particularly to be observed that the formulae expressed above give the pressure at which the boiler will explode and not the pressure at which it may be safely operated. It is usual in boiler practice to fix the allowable working pressure for a new boiler at **one-fifth** the computed bursting pressure and to decrease the pressure allowance as the age of the boiler increases.



SMALL VERTICAL BOILER EXPLOSION. 5 KILLED; BUILDING DESTROYED.

This is equivalent to saying that the factor of safety applied to a new boiler is usually not less than **five.** The term "factor of safety," however is so often misunderstood that I have thought a better name for it would be "factor of ignorance." It really is as much a factor of ignorance as it is a factor of safety.

Take, for example, the case of a new boiler operated with the safety-valve set at 100 pounds. If the computed bursting pressure be 500 pounds then the assumed factor of safety is **five.** The assumption, however, is based upon the tensile strength stamped in the plate by the steel maker and this strength is only true of that particular part of the plate from which the test specimen was cut and not necessarily true of any other part.

As a matter of fact it is current practice to cut the test specimen from the outer edge of the plate and the strength there is almost invariably greater than the strength at the center of the plate. The reason is that after liquid steel is poured into a mould its solidification in forming an ingot proceeds in much the same manner as does the solidification of water in forming a block of ice. That is to say, the impurities and gases are driven toward the centre, as almost every

BOILER EXPLOSION, GREENWICH COLD STORAGE CO., NEW YORK, N. Y.
TUBES IMPROPERLY ROLLED IN TUBE SHEET.

one has observed when looking through a clear block of manufactured ice. Boiler plates made by the rolling of such an ingot will therefore, have more impurities and less strength at the centre of the plate than at the outer edges, and this variation in strength is very considerable. Then too, it should be borne in mind that the stress at which the elastic limit of the material is reached is little more than **half** the stress at which rupture occurs.

Besides our ignorance of the dependable strength in all parts of the plate, there is also our ignorance of the character of the workmanship in the boiler. We cannot be certain that all rivet holes come fair, or that incipient cracks have not been set up by an abuse of the material during the process of construction.

It is seen, therefore, that factors of safety are really made up of two parts—one part a true factor of safety, the other a pure factor of ignorance. If this matter were better understood, boiler owners would themselves insist upon a computed factor of safety of not less than five and they would not be so persistent, as many are, in demanding that their boiler insurance company grant an unwise increase of pressure.

BOILER EXPLOSION, LAKEPORT STEAM LAUNDRY, LAEONIA, N. H.
1 KILLED; 7 INJURED; PLANT WRECKED. OLD BOILER;
DEFECTIVE MATERIAL.

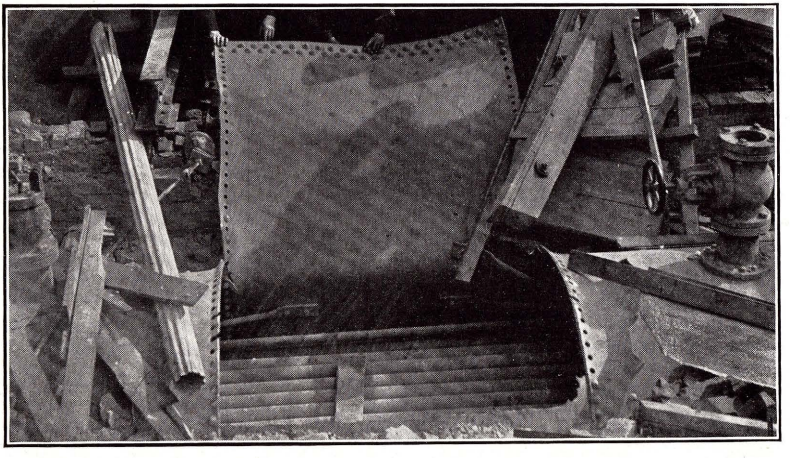
Causes of Boiler Explosions

Boiler explosions may be attributed to improper construction, improper installation, or incompetent or careless operation.

Improper construction may consist: of unsuitable or inferior material; poor workmanship; abuse of material, as when unmatched rivet holes are drift-pinned to place, or uncylindrical shells are sledged to form; of employing the more dangerous lap-joint for the side seams instead of the more safe and more sensible butt-joint, etc.

The lap-joint is dangerous because this form of construction promotes the formation of incipient cracks in the upper surface of the lower lap where they may be impossible of detection. These cracks extend from rivet-hole to rivet-hole and gradually deepen with the continued raising and lowering of the steam pressure until the metal, no longer capable of resistence, gives way and causes a violent explosion.

The lap-joint is given the preference over the butt-joint solely, because, it appears at first thought to be cheaper. Its labor cost doubtless is lower, but its lower efficiency makes necessary the employment of thicker plates to withstand the required steam pressure; and so the greater cost of the mat-



BOILER EXPLOSION, WYOMING VALLEY LACE MILLS, WILKES-BARRE, PA. HIDDEN LAP SEAM CRACK.

erial together with the heavier freight charges really make the lap-joint the more costly of the two. There is, therefore, no excuse for its existence, and its employment in the construction of new boilers should be prohibited by law in all states, as it now is in some.

Improper installation may consist of so supporting the boiler and its piping as to allow temperature changes to set up dangerous stresses in the material, of improperly attaching the usual appurtenances such as safety valves, steam and water gauges, check, blow-off, and stop valves, etc.

Incompetent or careless operation may consist in allowing the steam-gauge to get out of order, in allowing the water-gauge connections to become so clogged as to indicate ample water when there is none in the boiler, in allowing the safety-valve to become so stuck to its seat as to fail to blow at the pressure for which it was set, in allowing grease to enter or scale to accumulate in the boiler, in allowing large quantities of cold water to be impinged against hot plates, in allowing the water to be driven from the heated surfaces by forced firing, in allowing a large valve to be opened too suddenly, in allowing two boilers to be cut in on the same steam main when

PASSENGER BOILER LOCOMOTIVE EXPLOSION, SAN ANTONIO, TEXAS. 30 KILLED; 50 INJURED; BUILDING DESTROYED. SAFETY VALVE SET BY DEFECTIVE STEAM GAUGE; BOILER UNINSURED.

their pressures are unequal, and in allowing minor repairs to be neglected until they endanger the whole structure.

It is significant that many violent boiler explosions occur either just prior to the starting of the engines in the morning, or while they are idle at the noon hour, or shortly after they have been shut down for the day. The reason is that when steam is not being drawn from the boiler it accumulates rapidly; and if the safety valve fails to relieve the pressure, explosion soon follows.

The rapidity with which the bursting pressure is reached may be shown as follows:

Let T equal the time in minutes required to reach the bursting pressure, W the weight of water in the boiler, t the temperature of the steam at bursting pressure, t′ the temperature of the steam at normal working pressure, and U the number of heat units per minute supplied by the furnace and absorbed by the water. The heat balance is then represented by the equation:

$$UT = W\,(t - t')$$

$$T = \frac{W}{U}\,(t - t')$$

which stated in words, means that if we multiply the difference

BOILER EXPLOSION, ROBINSON CLAY PRODUCTS CO., MIDVALE, OHIO. 2 KILLED; PROPERTY LOSS, $24,000. BOILER CONNECTED TO BATTERY WHEN PRESSURE WAS DIFFERENT.

between the temperature of the steam at bursting pressure and at normal pressure by the weight of the water in the boiler, and then divide the product by the number of heat units supplied per minute by the furnace, the result will be the number of minutes that will elapse from the time the openings are all closed until explosion follows.

Take for example a 100 H.P. Horizontal Tubular Boiler containing at normal level, 10,000 pounds of water and suppose it uses 50,000 heat units per minute when evaporating 50 pounds of water per minute. Then if the normal gauge pressure be 85 pounds, the corresponding temperature of the steam is 327°, and if the bursting gauge pressure be 485 pounds, the corresponding temperature of the steam is 467°; and the time required to reach the bursting pressure with all steam openings closed and the safety valve stuck is:

$$T = \frac{10{,}000}{50{,}000}(467 - 327) = 28 \text{ minutes.}$$

That is with a stuck safety valve, only 28 minutes would elapse from the time the engines were shut down until the explosion followed.

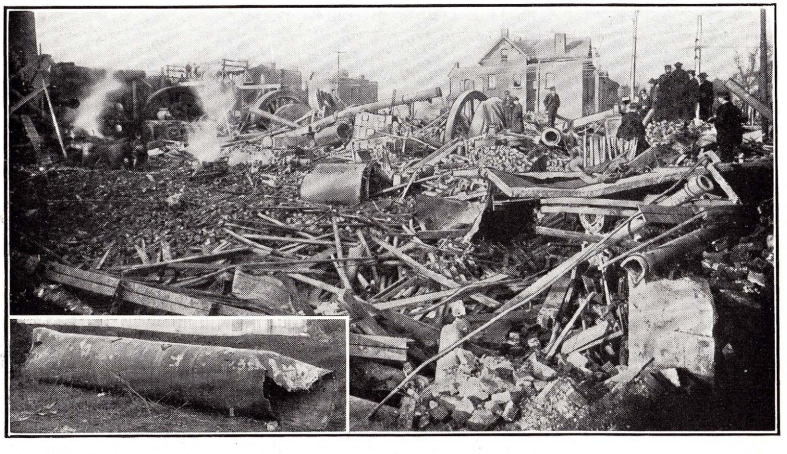
BOILER EXPLOSION, SUSQUEHANNA IRON & STEEL CO., YORK, PA. 9 KILLED; 20 INJURED; PROPERTY LOSS, $150,000. UNINSURED BOILER HAD NO WATER OR STEAM GAUGE AND SAFETY VALVE STUCK.

Explosive Energy in Heated Water

The temperature of the water in a boiler is approximately the same as the temperature of the steam with which it is in contact. If the fire be drawn when the openings are closed, ebullition ceases. If a valve be opened, ebullition starts again, even though there still be no fire under the boiler.

It is plain, therefore, that with the openings closed it is the pressure on the surface of the water that prevents further generation of steam. It is also plain that if a small rupture occurs below the water line a violent explosion may not ensue. But it ought to be evident that if a large outlet above the water line be suddenly opened, as, for example, when a steam-pipe fails, then the sudden liberation of the pressure on the surface of the high-temperature water will allow it to flash suddenly into steam and cause a violent explosion and water-hammer that will disrupt the strongest possible construction.

It is in this manner that most violent explosions are produced. The violence is incomprehensible to the layman who sometimes jumps to the conclusion that dynamite instead of steam caused the disaster. There is, however, no warrant for such a conclusion. A cubic foot of heated water under 60 to 70 pounds pressure contains about as much stored-up



WATER TUBE BOILER EXPLOSION, ST. LOUIS TRANSIT CO. 7 KILLED; 19 INJURED; PROPERTY LOSS, $112,000. CAUSE, BREAKAGE OF STEAM HEADER.

energy as a pound of gunpowder; and it has been estimated that the heated water in an ordinary cylindrical boiler contains enough energy to project the boiler to a height of two miles!

Grease in Boilers

The action of grease in a boiler is peculiar. Grease does not dissolve or decompose in water, nor does it remain on the surface. Heat in the water and its violent ebullition causes the grease to form in sticky drops which adhere to and varnish the metal surfaces of the boiler. This varnish by preventing the water from coming into intimate contact with the metal, prevents the water from absorbing the heat, and this causes a blistering or burning of the plate that often results in a serious rupture, or a violent explosion.

Scale in Boilers

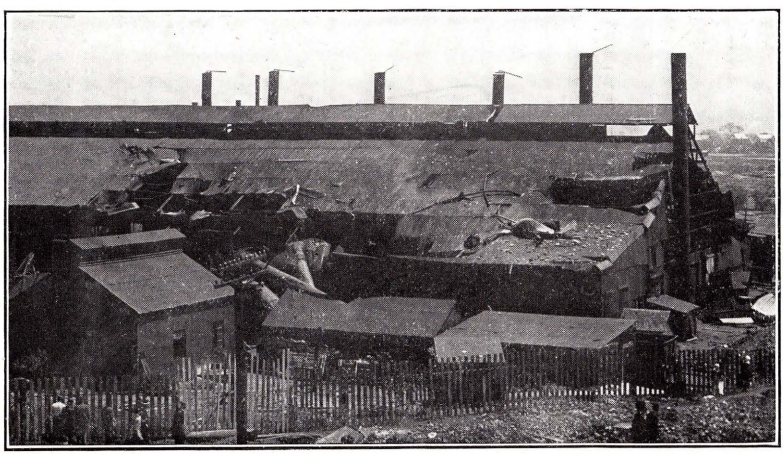
If scale is allowed to accumulate to any considerable thickness in a boiler, a bag or rupture of the boiler is inevitable, unless, perchance, the scale happens to be of a spongy formation, which is not often the case. Just why this is so, is shown by the following simple experiment.

BOILER EXPLOSION, MOREWOOD LAKE ICE CO., PITTSFIELD, MASS. 17 KILLED; 30 INJURED; PROPERTY LOSS, $30,000. SAFETY VALVE SET BY DEFECTIVE STEAM GAUGE.

Take an ordinary granite iron or tinned iron stewpan and firmly glue to its underside a postage stamp. Pour water into the pan and place it on a gas stove so that the postage stamp will be in direct contact with the flame. Leave the pan on the stove until the water has boiled violently and then examine the stamp. The stamp will not even be charred, much less burned. In fact it may be removed from the bottom of the pan and used to post a letter in the regular way. And this, notwithstanding the fact that it was on the underside of the pan and in direct contact with the hottest part of the flame.

Now put into the pan a mixture of water and Portland cement half an inch thick. This, when set, will be the equivalent of half an inch of scale. Repeat the experiment made before and it will be found that the stamp will burn up very quickly.

The reason that the postage stamp on the bottom of the vessel is not charred by the flame when no scale is present is that the water, being in immediate contact with the thin bottom of the vessel, absorbs the heat as fast as it is put into the vessel by the flame. The result is that, no matter how hot the flame may be, the bottom of the vessel remains at practically the same temperature as the boiling water with



BOILER EXPLOSION, AMERICAN SHEET AND TIN PLATE CO., CANTON, OHIO. 13 KILLED; 40 INJURED; PROPERTY LOSS, $100,000. BOILER CONNECTED TO BATTERY WHEN PRESSURE WAS DIFFERENT.

which it is in contact. In an open vessel the temperature of boiling water, of course, is 212 degrees and this is not sufficiently high to char paper. When scale is present, the water cannot absorb the heat as fast as it is put into the vessel by the flame, as a result of which the temperature becomes greater than 212 degrees and burns the postage stamp.

It is the same with steam-boilers. If the water comes in direct contact with the thin plates, the heat is absorbed, the temperature of the plates remains practically the same as the water, and no harm is done. If there be a considerable thickness of impervious scale in the boiler, the water cannot absorb the heat as fast as it is put into the plates by the furnace, and so the plates become overheated, get red, become plastic, and finally give way to the force of steam pressure, causing a bag, or a rupture, or a violent explosion of the boiler.

Scale endangers the safety of boilers in other ways. It clogs the feed pipes, preventing the feed water from freely entering the boiler. It clogs the connections to the water-gauge, causing it to indicate ample water when none at all is in the boiler. Pieces of it get under valves and prevent their closure. A blow-off valve, for instance, screwed down hard and thought to be shut, recently allowed all the water to leak out of the boiler, and caused its burning into a mass of warped

EXPLOSION OF FAT RENDERING TANK, KLINE BROS. SOAP CO., CHICAGO, ILL. PROPERTY LOSS, $40,000. INTERNAL CORROSION.

plates and bent tubes unfit for further use. Then, too, scale decreases the efficiency and increases the fuel consumption of the boiler.

Scale in boilers, therefore, is a serious matter. In order to prevent its accumulation, it is good practice to eliminate the scale-forming matter from the feed water before allowing it to enter the boiler. This can be accomplished either mechanically by means of separators, or chemically by treating the water in vats especially arranged for the purpose. If preferred, compound may be fed with the water into the boiler, but in such case the water should be analyzed, and the proper compound prescribed by a chemist making a specialty of such matters. Kerosene fed into the boiler has proven beneficial in many instances.

Inspection and Insurance

It is an almost universal custom for boiler owners to have their boilers insured and inspected. The insurance serves as a guarantee that the inspections will be intelligently and carefully made and the inspections lessen the chance of accident.

When boiler insurance is carried, an inspector of the insurance company visits the plant at regular intervals. He critically examines the boilers, both internally, and externally,

BOILER EXPLOSION, HEARN SAW MILL, SALISBURY, MD. 5 KILLED; 3 INJURED; MILL DEMOLISHED.

hammer-testing them thoroughly in order to discover defects or weakness. If he finds oil or scale in the boiler, a remedy is prescribed to eliminate it and to prevent its re-accumulation. He notes the exact condition of the boilers and secures all data necessary to determine the maximum steam pressure at which they are safe. He examines the brick setting, tries the safety-valves, tests the water-gauges, and standardizes the steam-gauges by comparing them with his standard test-gauge. And he inspects the piping, injectors, feed-pumps, and other apparatus auxiliary to the boiler.

Immediately upon completing his examination, the inspector makes a verbal report to the owner of the plant, and sends a written report to the insurance company. The insurance company then renders a written report to the owner confirming the verbal report already delivered by the inspector.*

The value of this system is reflected in the experience of The Fidelity and Casualty Company, the inspectors of which during the past ten years made 1,101,140 examinations and reported 140,989 defects, many of which consisted of dangerous

*The system here described is that of The Fidelity and Casualty Company.

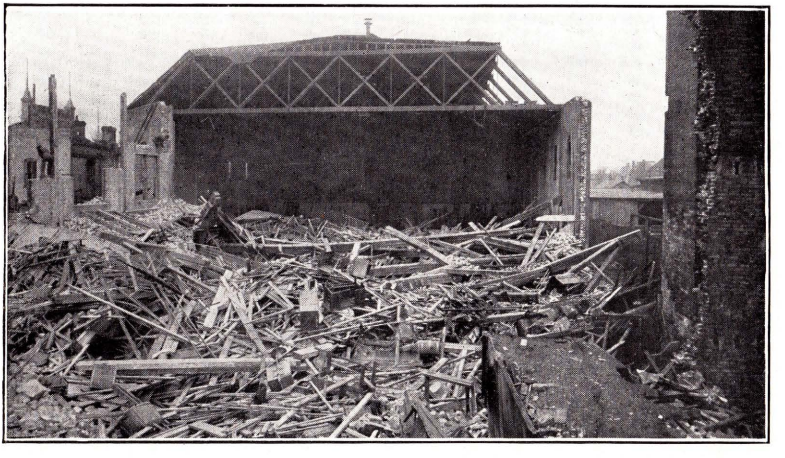
EXPLOSION OF TWO BOILERS, SALISBURY, MD. 2 KILLED; 2 INJURED; PLANT DESTROYED; SECOND DISASTER IN SALISBURY WITHIN TEN DAYS.

fractures in or near the riveted seams. It is significant that one boiler out of every eight examined, contained defects serious enough to warrant their being reported.

Many states wisely have passed laws providing for the examination and licensing of stationary engineers, and for the compulsory inspection of steam boilers. Such laws very properly exempt from state inspection, boilers inspected by boiler insuring companies. One of the best of these laws is the Massachusetts Law. It has been used as a model by the State of Ohio and by other states.

Unfortunately the state laws are not uniform. A boiler built in accordance with the laws of one state may be rejected if shipped into an adjoining state; and a state that has no such law may become the common dumping ground for old, worn-out, and dangerous boilers rejected from a state that has such laws.

Uniform laws are, therefore, greatly to be desired, and in an effort to secure uniformity, the American Society of Mechanical Engineers, has appointed a Commission to prepare a Standard Code for the Construction and Safe Operation of Steam Boilers. This Commission consists of Mr. Jno. A. Stevens, Consulting Engineer, Prof. R. C. Carpenter of Cornell,



BOILER EXPLOSION, CHICAGO & N. W. R. R. DEPOT, POWER HOUSE.
9 KILLED; 5 INJURED; PROPERTY LOSS, $90,000.

and Prof. E. F. Miller of the Massachusetts Institute of Technology, representing the steam users' interest; Mr. C. L. Huston, representing the steel manufacturers' interest; Mr. H. C. Meinholtz and Mr. Richard Hammond, representing the boiler manufacturers' interest; and Wm. H. Boehm, of The Fidelity and Casualty Company, representing the boiler insurance interest.

The Commission is now engaged in the preparation of this Code. When it is completed, it is hoped that steam users will want, and manufacturers will build their boilers in accordance with the A. S. M. E. Standard; that the states will adopt it as their standard; and that eventually complete uniformity will thus be brought about.

Boiler Insurance Policies

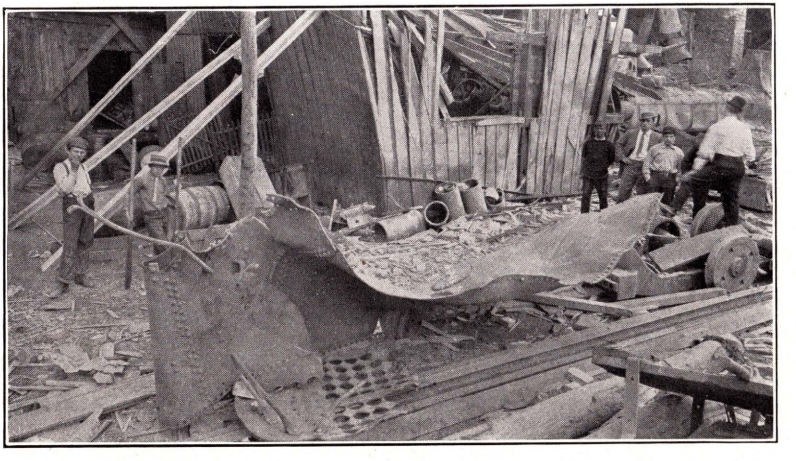
Steam-boiler insurance policies indemnify the assured against direct loss caused by a sudden and violent explosion, collapse, or rupture by force of steam pressure of any of the boilers described in the contract. The indemnity usually includes reimbursement for loss on the boilers themselves, loss on the property of the assured, loss on the property of others

CONTRACTOR'S BOILER EXPLOSION, CAMPBELL HOTEL, DALLAS, TEXAS. KILLED MAN, HIS WIFE AND TEAM OF MULES; WRECKED HIS WAGON AND DAMAGED HOTEL.

for which the assured is liable, and the liability of the assured for damages on account of bodily injuries or death sustained by employees or by others not employees.

Some boiler insurance policies cover property damage only. It is better, however, to include the personal injury feature, because, even if the assured carries an employers' liability policy, the usual amount of insurance under such a policy is inadequate to take care of the great number of personal injury claims likely to result from a disastrous boiler explosion. The boiler policy does not cover minor accidents such as bags, blisters, or fire cracks, unless a sudden and violent explosion, collapse, or rupture results; but it does cover in the latter case even though the accident be due to the negligence of the assured or his employes. This does not mean, however, that the assured, or his agents or any of his employes may deliberately set the safety-valve for a pressure greater than the safe limit stipulated in the contract.

In some boiler insurance policies the personal injury indemnity is made excess insurance over the indemnity under the liability policy instead of contributing insurance. That is to say, the personal injury indemnity under the boiler policy is not available until after the indemnity under the

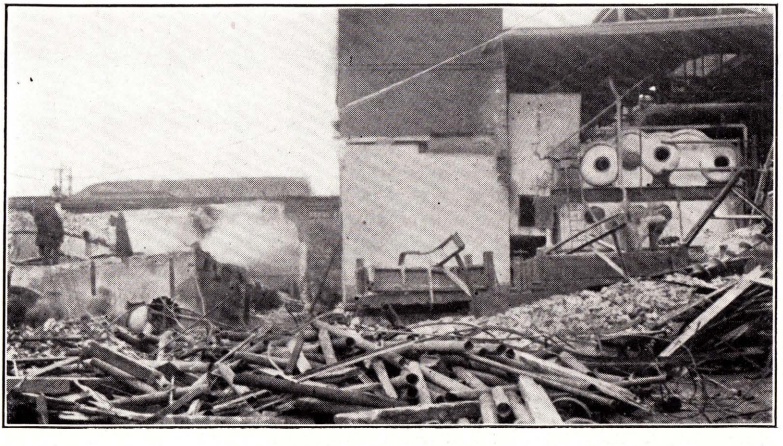


BOILER EXPLOSION, DIAMOND COAL & COKE CO., CHEWTOWN, PA.
3 KILLED; 6 INJURED; OLD BOILER NOT INSURED.

liability policy has been exhausted in the settlement of claims. The excess plan is better for the assured than the contributing plan, because by settling personal injury claims under the liability policy up to its full limit, the assured has just that much more insurance under his boiler policy to apply in the settlement of property damage.*

Some policies contain two limits—a limit for each person injured or killed, and a total limit applying both to property damage and to personal injuries. Some policies contain three limits—a limit for each person injured or killed, a limit for each accident, and a total limit to take care of a number of accidents should more than one occur. In some policies this third limit is not expressed, the contract being so drawn that the limit per accident is available for as many accidents as may occur during the time the policy remains in force.* In some policies the insurance applies specifically to each boiler, in others to each plant, and in others to each accident that may occur.

*This feature is contained in the "Multiple Indemnity Boiler Policy" of The Fidelity and Casualty Company and described on the 2nd cover page of this pamphlet which see.



EXPLOSION OF ECONOMIZER GLENLYON DYE WORKS, SALESVILLE, R. I. 3 KILLED 6 INJURED; PROPERTY LOSS $50,000. INSURED UNDER BOILER POLICY.

The limit for each person injured or killed is $5,000 in the standard policy, but this is often increased by endorsement. The limit per accident is frequently made equivalent to $5,000 multiplied by the number of boilers in the plant, but a more rational method is to determine the limit from a careful consideration of the plant and its surroundings. In any event, the amount of insurance determined upon should be sufficient to take care of the total amount of property-damage and personal-injury claims likely to result if accident occurs; and care should be taken to have the contract so explicit, and so free from ambiguities that the basis of settlement shall be unmistakable. An ambiguous contract may lead to an expensive legal dispute.

EXPLOSION OF LOW PRESSURE HEATING BOILER, GREENWICH ACADEMY, EAST GREENWICH, R. I. TWO GIRLS IN UPPER DORMITORY ROOM MIRACULOUSLY ESCAPED INJURY.

THE FIDELITY AND CASUALTY COMPANY OF NEW YORK

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Accident..C. V. Everitt and W. H. Boehm
Plate-Glass.....Nelson D. Sterling
Liability—W. J. Johnson and J. L. Houston
Boiler and Fly-Wheel..William H. Boehm
Burglary.N. D. Sterling and W. P. Learned
Agency.....Allan J. Ferres
Inspections.....Daniel C. Harvey
Claims.....Frank E. Law
General Counsel.....Charles C. Nadal

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Cal.—C. B. Cornell.....San Francisco
Canada—B. Minehan.....Toronto
Canada—Paul H. Boring.....Montreal
Canada—Seeley & Co., Inc.....Vancouver
Canada—Ryan Agency, Ltd.....Winnipeg
Col.—George W. Beck.....Denver
Conn.—A. S. Hopkins.....Hartford
Dist. of Col.—Edgar K. Legg, Jr., Washington
Ga.—Eugene Oberdorfer.....Atlanta
Ill.—W. A. Alexander & Co.....Chicago
Ind.—Edgar M. Heaton.....Indianapolis
Ky.—C. L. Nelson.....Louisville
La.—Edward St. John.....New Orleans
Md.—Walter Duvall.....Baltimore
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Mass.—Gale, Durant & Gale.....Pittsfield
Mass.—J. S. Woodall & Co.....Springfield
Mich.—Benson & Upington.....Detroit
Minn.—Chas. W. Sexton Co...Minneapolis
Mo.—J. H. Rush.....Kansas City
Mo.—H. R. McMurtrie & Co...St. Joseph
Mo.—F. E. Fowler & Co.....St. Louis
Mo.—R. A. Hoffmann.....St. Louis
Mo.—Robert L. Dutton.....St. Louis
Mont.—B. P. McNair.....Great Falls
Neb.—Foster-Barker Company.....Omaha
N. H.—Fred H. Nourse.....Lancaster
N. J.—Harry A. Smith.....Hoboken
N. J.—Jos. M. Byrne Co.....Newark
N. Y.—Edgar E. Mueller.....Buffalo
N. Y.—Benjamin Sturges.....New York
N. Y.—E. E. Clapp & Co.....New York
N. Y.—M. E. Wollf Co.....Rochester
N. D.—O. A. Webster.....Grand Forks
Ohio—Chas. H. King.....Cleveland
Ohio—Jas. R. Millikan.....Cincinnati
Okla.—Upsher and Upsher..Oklahoma City
Oregon—Seeley & Co., Inc.....Portland
Pa.—S. H. Pool.....Philadelphia
Pa.—John L. Rivolta.....Pittsburgh
R. I.—G. L. & H. J. Gross.....Providence
Tenn.—Vance Powell & Co.....Memphis
Texas—I. Reinhardt & Son.....Dallas
Utah—Geo. W. Peck Co.....Salt Lake City
Va.—Robert Schaefer.....Richmond
Vt.—Jake Heyman.....Rutland
Wash.—Seeley & Co., Inc.....Seattle
Wis.—F. E. Delaney.....Milwaukee

ANNUAL FINANCIAL STATEMENT, DECEMBER 31, 1914

ASSETS

Stocks and Bonds	$8,292,317.71
Real Estate	1,368,893.45
Cash in Banks and Office	616,792.15
Gross Premiums in course of collection (not overdue)	1,394,398.05
All other Assets	186,328.17
	$11,858,729.53

LIABILITIES

Reserve for Unearned Premiums	$4,915,445.39
Liability Claims resisted for policy-holders	1,008,114.00
Losses In process of adjustment	741,886.00
Steam Boiler Losses, in process of adjustment	21,528.00
All Other Losses, in process of adjustment	926,057.80
Commission on Premiums in course of collection	362,395.34
All other Liabilities	344,182.19
Surplus to Policy-holders ...	3,539,120.81
	$11,858,729.53

Reserve for Contingencies. Not required by law	
Capital Stock	$500,000.00
Net Surplus	1,000,000.00
	2,039,120.81

Amount of All Losses Paid to Date, December 31, 1914....$48,580,800.32

1876 - 1915

The Fidelity and Casualty Company of New York

92 Liberty Street (Just West of Broadway)

THIS COMPANY GRANTS INSURANCE AS FOLLOWS:

BONDING DEPARTMENT

1. FIDELITY—Against loss by defalcations of persons in positions of trust.
2. SURETY—Against loss by defaults of principals under bond.

ACCIDENT DEPARTMENT

1. PERSONAL ACCIDENT—Against death and loss of time caused by accidental bodily injuries.
2. HEALTH—Against loss of time caused by sickness.

PLATE-GLASS DEPARTMENT

Against loss by accidental breakages.

LIABILITY DEPARTMENT

1. EMPLOYERS' LIABILITY—Against damages for personal injuries sustained by employees of manufacturers, miners, contractors, etc.
2. EMPLOYERS' PUBLIC LIABILITY—Against damages for personal injuries sustained by persons other than employees through industrial operations.
3. TEAMS—Against damages for personal injuries caused by horses and vehicles.
4. AUTOMOBILE—Against damages for personal injuries caused by automobiles.
5. WORKMEN'S COLLECTIVE—Collective personal accident insurance for workmen in industrial establishments.
6. PHYSICIANS' AND DRUGGISTS' LIABILITY—Against damages claimed by patients or customers.
7. OWNERS' AND LANDLORDS' LIABILITY—Against damages for personal injuries sustained by persons on their premises.
8. PASSENGER ELEVATORS—Against damages for personal injuries sustained by passengers.
9. WORKMEN'S COMPENSATION—Against compensation payable to employees under Workmen's Compensation Acts on account of personal injuries.

BOILER AND FLY-WHEEL DEPARTMENT

1. STEAM-BOILER—Against, 1st, the direct loss of property; 2nd, damages for property of others destroyed; 3rd, damages for personal injuries: caused by explosion of steam-boilers.
2. FLY-WHEEL—Against, 1st, the direct loss of property; 2nd, damages for property of others destroyed; 3rd, damages for personal injuries: caused by disruption or explosion of fly-wheels.

BURGLARY DEPARTMENT

For bankers, merchants, householders and others against loss by burglary.

¶ **The Company, in its Bonding, Boiler, Elevator and Fly-Wheel Departments, employs skilled inspectors, makes thoroughgoing inspections, and reports thereupon to the assured**